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Consumer behavior with augmented reality in retail: a review and research agenda

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Driven by the rapid technological development and adoption of augmented reality (AR) in retail, academic research has grown rapidly. Our purpose is to understand the reasons why consumers use augmented reality in retail and what outcomes retailers can expect. This study presents a systematic literature review and summarizes the current empirical knowledge on consumer behavior with AR in retail. This topic remains scattered between various literature streams showing that the potential of AR to create value for consumers lays in its ability to generate utilitarian and hedonic value, to improve decision-making, and to enhance personalization of the virtual self. Then, this study warns about negative effects of AR usage. The contribution is a systematic literature review and a conceptual framework covering the most important consumer behaviors with AR and their brand-related, transactional, and technology-related outcomes. In addition, this paper adopts a holistic view to propose future research directions and emphasize the need for more research on social augmented reality.

Keywords: augmented reality; retail; experience; self; decision-making

Introduction

Augmented reality (AR) refers to a set of technologies that superimposes digital information and images on the physical reality of the user, thus creating a new interface between the digital and physical worlds (Javornik 2016b; Porter and Heppelmann 2017; Yim, Chu and Sauer 2017). The AR market in retailing is expected to reach USD 11.4 billion by 2025 with an annual growth rate of 39% (MarketsandMarkets, 2019), which underlines the potential that retailers perceive in AR technologies (Piroth, Rüger-Muck and Bruwer 2020). In particular, by enhancing consumers' shopping experience and reducing decision-making uncertainty, AR

may relieve online retailers' mounting problems with low conversion rates, high shopping cart abandonment and high product return rates, all of which have a significant impact on financial performance (Janakiraman, Syrdal and Freling 2016).

In addition, augmented reality-branded apps may be used in a multi-channel strategy, in order to provide value to consumers that goes beyond information search and responds to consumers' experiential needs (Yrjölä, Spence and Saarijärvi 2018). In addition to the enhanced convenience in terms of savings in transportation and shopping time, AR helps consumers in their arduous task of mentally translating 2-D information into the 3-D world, by providing an interface that aligns with consumers' natural information processing (Hilken et al. 2017; Porter and Heppelmann 2017). Many retailers have incorporated AR as part of their service experience to focus on the interaction between consumers and retail frontline (Hilken et al. 2017). Harnessing the power of information in context, AR is changing how consumers shop (Cook et al. 2020). AR displays information in context that is aware of the consumer, its physical environment (Hilken et al. 2017), and enhances the felt presence of others (Grewal et al. 2020).

Three different modes of AR shopping coexist: augmentation of the self (e.g., YouCam Makeup; Park and Yoo 2020), augmentation of one's direct environment (e.g., IKEA Place; Rauschnabel, Felix, and Hinsch 2019), and augmentation of an object (e.g., Dessert menu; Heller et al. 2019a). The common uses of AR shopping are for glasses, makeup, and furniture (Cook et al. 2020), and these uses have also received the most research interest. AR technology helps consumers imagine how the cosmetics products or glasses look on themselves and to explore a new look or new color (Heller et al. 2019a), thus enabling them to browse through a large range of products more easily. Brands such as L'Oréal and Wayfair deliver "try-before-you-buy" experiences that enable consumers to point their live cameras on themselves or into their homes and overlay 3-D virtual products (Power 2019). In addition to its look, how the

furniture fits in the room is displayed through a true-to-scale visual representation of the room (Power 2019). Augmentation of an object has been implemented by Dulux, a company that allows users to pick a paint color for their wall and explore different options for the wall digitally; their app also enables sharing of the visualization as a video or picture. As consumers can see the information in context, it brings confidence into their purchase decisions (Power 2019). L'Oréal emphasizes that the AR experience is about personalized advice and sharing with the brands' experts. Therefore, L'Oréal provides tutorials to teach consumers how to apply makeup, and they have created a skin analyzer to improve consumers' skincare choices. In a promising development in social AR shopping, Dior uses Snapchat to implement augmented shopping, thereby enabling their wide audience to share their try-before-you-buy experiences and to receive suggestions from other consumers (Adweek 2020). Therefore, AR delivers a high-convenience, high-social-presence experience, which is crucial for the future of in-store technology (Grewal et al. 2020). Consequently, AR has the potential to improve consumers' ability to absorb product information more efficiently, to make better purchasing decisions, and to obtain enjoyment from enhanced shopping experiences (Dacko 2017; Huang and Liao 2015).

In response to the growing interest in the industry, scholarly attention to AR in retailing has increased in recent years. The empirical research has contributed to our knowledge of AR retailing applications from various aspects, such as technology acceptance (e.g., Huang and Liao 2015), consumer decision-making (e.g., Hilken et al. 2019), and user experience (Poushneh and Vasquez-Parraga 2017). However, the fragmentation of AR research into numerous literature streams and theoretical approaches makes it difficult to obtain a holistic picture of the current evidence, and there is an urgent need to provide an overview of AR research that would help scholars position their scholarly efforts within a broader realm of AR phenomena in retailing.

Against this backdrop, this study presents a literature review on empirical research conducted in the context of AR in retailing that aims to answer the following research questions. 1) What is the current state of research in the field of AR in retail? 2) What are the key consumer behavior phenomena related to AR in retailing? 3) What are the consequences of AR usage on consumer attitudes and behavior? 4) Which research gaps remain to be addressed? This research contributes to the existing literature by generating a systematic account of the literature and combining various literature streams into one framework that demonstrates the key consumer behavior phenomena related to AR in retailing. Based on in-depth investigation of current research, the study proposes a number of important future research avenues.

This article starts by explaining the background for the literature review and positioning it against previous AR-related literature reviews. Then, the methodological choices in the identification and selection of suitable studies for the review are explained. Next, this paper describes the theoretical approaches, contexts, and methods that have been used in AR research. Subsequently, a framework is presented that provides a comprehensive view of AR consumer behavior phenomena and analyzes in detail the studies that relate to these phenomena. Finally, the future research agenda, conclusion, and limitations are discussed.

Background

AR and its applications in retail have developed rapidly due to rapid technological development, and the topic has naturally drawn attention in academic research as well. Unfortunately, the academic research is fragmented, probably due to the interdisciplinary origin of the topic (Bonetti, Warnaby and Quinn 2018). As the body of academic research on AR in retail and e-commerce grows, there is a need for literature reviews to take stock of past research on the topic and to suggest an agenda for future research. Previous literature reviews

on AR have focused on the differences between augmented reality, mixed reality and virtual reality (Flavián et al. 2018), active and passive ingredients of AR marketing programs (Scholz and Smith 2016), mobile AR research at different levels of analysis (users, devices, and industry) (Liao 2019), and the role of AR in omnichannel experiences across the customer journey (Hilken et al. 2018). In light of our focus on consumer behavior with AR in retailing, we identify three reviews that are particularly relevant to our work. First, Javornik (2016a) reviews how media characteristics of AR are related to consumer responses. Second, Bonetti, Warnaby, and Quinn (2018) review AR research and organize it into three key debates in the field. In the remainder of this section, the foundational work presented in these reviews is summarized to explain how our review complements the lessons learned from them. Third, Caboni and Hagberg (2019) review literature on AR in retailing and identify three types of AR applications in retailing, as well as their benefits to consumers and retailers.

Javornik (2016a) grounds her work in communication literature and assembles a framework that depicts the media characteristics[1] of interactive media. In her review of studies, she organizes AR studies with these media characteristics and links the media characteristics to different consumer responses. As a conclusion in her review, Javornik (2016a) observes that AR differs from other interactive technologies in that augmentation (i.e., the "ability to overlay physical environments with virtual elements", p. 259) is its defining characteristic. Since Javornik's (2016a) review, augmentation and its qualities have been regarded as among the key features of AR (Rauschnabel, Felix and Hinsch 2019; Poushneh 2018; Javornik 2016b). Javornik (2016a) concludes that other symptomatic aspects of AR are location-specificity, mobility, and machine- or space-related interactivity. The media characteristics or features such as environmental embedding and simulated physical control (Hilken et al. 2017), AR

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[1] The media characteristics in Javornik's (2016a) study are interactivity, hypertextuality, modality, connectivity, location-specificity, mobility, and virtuality.

generation and AR transformation (Heller et al. 2019a), and vividness (Yim, Chu, and Sauer 2017) capture these aspects.

Bonetti, Warnaby, and Quinn (2018) chronologically review AR-related research in retail and provide a synthesis of key debates in the field. They structure the key debates into three categories: adoption, applications, and acceptance. The adoption-related debate revolves around retailers' adoption of AR technologies and the actual purposes and benefits of adopting the technologies. For example, does the use of technology merely capture consumers' attention, or is it truly a viable solution (Bonetti, Warnaby and Quinn 2018)? Under applications, Bonetti, Warnaby and Quinn (2018) recognize that AR applications in retail are mainly virtual fitting room applications, and they include the e-commerce context as well as in-store use of AR. The acceptance debate in Bonetti, Warnaby, and Quinn's (2018) review mainly discusses the drivers of consumers' acceptance of AR technologies, in which the technology acceptance model (TAM, Davis 1989) plays the main role.

Caboni and Hagberg (2019) review literature on AR in retailing. They identify that the three major applications of AR in the retailing context are online web-based, in-store, and mobile applications. Furthermore, they synthesize the current knowledge of the potential value of AR for consumers and retailers. Caboni and Hagberg (2019) conclude that the benefits of AR for consumers include enhanced interaction with products and brands, augmentation of the shopping experience, and involvement in product personalization.

All of these reviews (Bonetti, Warnaby and Quinn 2018; Caboni and Hagberg 2019; Javornik 2016a) are helpful in organizing the research literature on AR in retail. It seems that the emphasis is gradually changing from defining AR technology to a more nuanced understanding of its impact on consumer behavior in retail. Javornik's (2016a) work clearly distinguishes AR technology from other interactive technologies and recognizes the core features of AR that are linked to consumer responses. However, since the research literature is

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organized by the media characteristics of AR, Javornik's (2016a) review does not offer a clear synthesis of the actual consumer responses that can be achieved with AR. Bonetti, Warnaby, and Quinn's (2018) review organizes literature on the research themes, which helps to distinguish between retailers' perspectives on AR and consumers' perspectives on accepting and adopting AR technologies. While these authors recognize that retailers might search for different consumer responses (e.g., mere attention vs. long-term benefits), they limit their analysis of consumer responses to technology acceptance. Caboni and Hagberg (2019) defined the three major types of AR applications and identified different types of value for consumers and retailers. Their review opens consumers' perspectives by increasing our understanding of the AR's value drivers for consumers in comparison to retailers. While Caboni's and Hagberg's (2019) review does provide important insights on consumer behavior, it looks at consumer behavior from the retailer's point of view. Consequently, the focus is on retailers' desired outcomes, such as satisfaction and shopping experience.

Our literature review seeks to complement the reviews of Javornik (2016a), Bonetti, Warnaby, and Quinn (2018), and Caboni and Hagberg (2019) by examining AR in retail as a context and by organizing the literature according to different consumer behavior phenomena. Therefore, this review includes the consumer's role as a change agent (in comparison to retailers' desired outcomes) and identifies the research stream that focuses on the consumer's virtual self.

Methodology

We identified articles that addressed the issue of consumer behavior with AR in retail by following the two-stage approach suggested by Webster and Watson (2002) and by Boell and Cecez-Kecmanovic (2015). In the first stage, relevant articles are identified by a keyword search, followed by more rigorous inclusion and exclusion processes in the selection of the

articles in the second stage. In the first stage, we limited the search to journal articles because those findings are considered to be validated and are more likely to influence the academic and business fields (Podsakoff et al. 2005). We searched articles that were written in the English language in the online databases Scopus and Web of Science. The keyword searches were limited to the title and abstract of the articles. We adopted a broad range of terms coherent with our topic, both to limit irrelevant papers and to increase efficiency in identifying relevant papers. The searches were combinations of terms and are summarized in Table 1. In line with Boell and Cecez-Kecmanovic (2015), the selection of keywords evolved during the literature search process as we learned new terms that are commonly used in AR research (e.g., local presence, virtual try-on, and virtual fitting room).

Table 1. Keyword association for identification of relevant literature

First term	Second term
"augmented reality"	"marketing", "shopping", "retail*", "e-commerce", "consumer behavior", "consumer engagement", "experiential value", "customer experience", "point of sale"
"augmented reality"	"virtual shopping", "virtual try-on", "virtual fitting room", "virtual mirror", "experiential marketing", "virtual product interaction", "immersive store"
"marketing"	"virtual shopping", "virtual try-on", "virtual fitting room"
"experiential value"	"virtual shopping", "virtual try-on", "virtual fitting room"
"virtual mirror"	"consumers"
"local* presence"	"product"

Note: All entries are to be read as the association of the first term AND the second term (e.g., augmented reality AND "marketing").

In the second stage, we delimited the selection of articles in accordance with the following inclusion and exclusion criteria. First, we included only those articles that focused on AR in the context of retailing. Second, to ensure study quality, we included only articles listed in the Social Sciences Citation Index (SSCI) or the Science Citation Index Expanded

(SCIE). Third, we excluded conceptual approaches because our review focuses on empirical studies. Fourth, we excluded studies in which it was unclear whether the respondents had ever actually used AR because AR shopping is still difficult to understand or is unknown for most consumers (Dacko 2017). This process resulted in the identification of 45 peer-reviewed articles (marked with an asterisk in the references) from 2014 to December 2019 (see Appendix A). The starting time frame was not fixed by default; the earliest empirical study that focuses on consumer behavior with AR in our search results is from 2014.

Overview of reviewed articles

The reviewed articles adopt a wide range of theories to investigate AR in retailing. The most commonly used theoretical approaches are based on the TAM, socially situated cognition theory, and mental imagery theory. In Appendix B, we present a list of theories along with their descriptions. Methodologically, the studies were survey-based (e.g., Huang and Hsu Liu 2014; Rese, Schreiber and Baier 2014; Dacko 2017), or experimental (Beck and Crié 2018; Hilken et al. 2017; Javornik 2016b), or adopted multi-method approaches (Scholz and Duffy 2018). Notably, 23 studies used student samples (51%), and an additional seven studies used young adult samples (16%), which is typical of studies focusing on new technologies (Darley, Blankson and Luethge 2010) because students and young adults are known to be more open to innovative technologies (Yim, Chu and Sauer 2017). However, the disproportionate use of student and young adult samples (67% of studies) limits the generalizability of the findings to the broader population of online consumers (Verhagen et al. 2014). Existing studies also focus predominantly on hedonic and low-involvement product categories (e.g., fashion and entertainment) and interactions between the consumer and medium or brand, while consumer-consumer interaction facilitated by an AR app is seldom studied.

One notable issue is that AR is treated differently between studies. First, some studies treat AR as a set of features (e.g., interactivity and vividness) and investigate the impact of these features on dependent variables (Javornik 2016b). Second, some studies treat AR as a context to test the relationships of other variables and demonstrate the mechanisms that underlie the potential value of AR interfaces (Hilken et al. 2017; Heller et al. 2019a). Third, other studies compare the AR interface with standard web interfaces and investigate their differing impacts on dependent variables (e.g., Baek, Yoo and Yoon 2018).

Research streams of AR-enhanced consumer behavior in retailing

The literature analysis resulted in the identification of several subthemes related to consumer behavior with AR in retailing. These subthemes were subsequently categorized into four broader research streams. The first research stream addresses the utilitarian and hedonic value that AR creates, which explains the motivation to engage in and commit to AR shopping experiences. The second stream concerns decision-making and involves research on AR as an immersive experience, and related subthemes of local presence, flow, and mental imagery that facilitate decision-making and AR-enhanced shared decision-making. The third stream is labeled the virtual self and refers to the potential of the AR experience to trigger self-referencing and self-brand connection aspects, such as self-brand connection and self-brand congruity. The fourth stream addresses the negative effects of AR that entail concepts closely related to privacy concerns, such as perceived intrusiveness, discomfort, and users' control of access to personal information, as well as media irritation including issues about app quality. To conclude, we created a framework that highlights these four research streams as well as their antecedents and consequences that are commonly studied across the streams (Figure 1). Although the streams are not meant to be exclusive, the framework provides a meaningful synthesis of major research avenues.
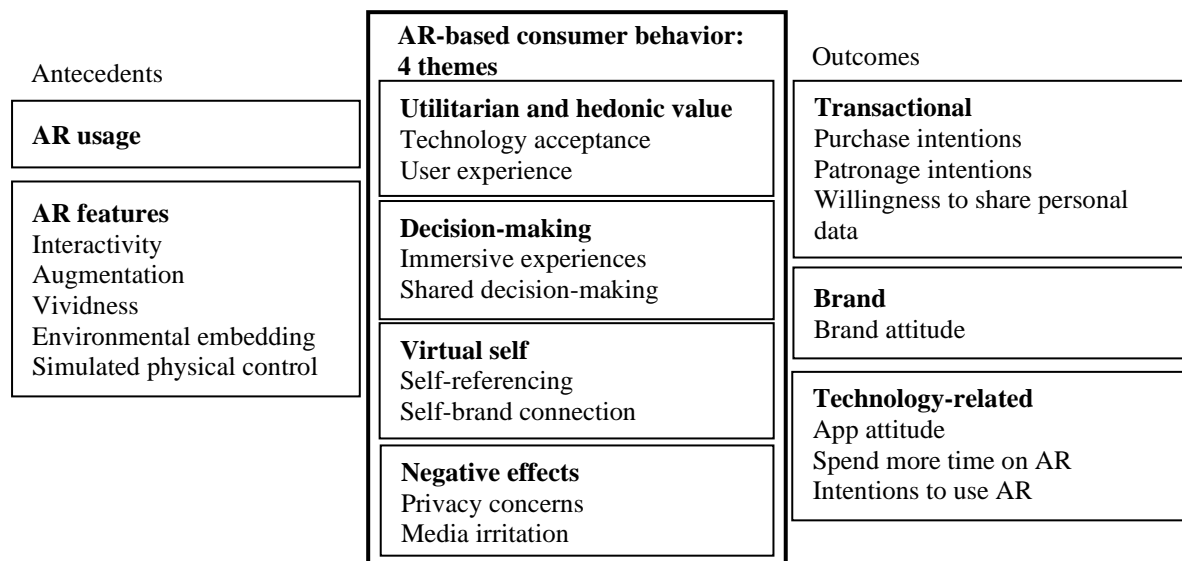
Antecedents	AR-based consumer behavior: 4 themes	Outcomes
AR usage	**Utilitarian and hedonic value** Technology acceptance User experience	**Transactional** Purchase intentions Patronage intentions Willingness to share personal data
AR features Interactivity Augmentation Vividness Environmental embedding Simulated physical control	**Decision-making** Immersive experiences Shared decision-making	**Brand** Brand attitude
	Virtual self Self-referencing Self-brand connection	**Technology-related** App attitude Spend more time on AR Intentions to use AR
	Negative effects Privacy concerns Media irritation	

Figure 1. Framework of consumer behavior with AR

Utilitarian and hedonic value

An AR-enhanced user experience can create hedonic and utilitarian value; the former refers to enjoyment, while the latter refers to the effectiveness of the experience (Rauschnabel, Felix and Hinsch 2019; Poushneh 2018; Hilken et al. 2017). The role of AR in creating utilitarian and hedonic value is often studied via the TAM. The TAM has been extended to include utilitarian (e.g., ease of use, usefulness, and informativeness) and hedonic value (e.g., enjoyment) to predict intention to use AR (e.g., Pantano, Rese and Baier 2017). Studies include more specific dimensions that rely on the user experience concept, such as quality of information, aesthetic quality, response time, and interactivity (Pantano, Rese and Baier 2017). Overall, both utilitarian and hedonic value predict the intention to continue using AR (Rese, Schreiber and Baier 2014; Rese et al. 2017; Yim and Park 2019; Pantano, Rese and Baier 2017; Huang and Liao 2015). Furthermore, utilitarian and hedonic value positively impact brand-related and app-related attitudes (Rauschnabel, Felix and Hinsch 2019). Consumers with high cognitive innovativeness are more likely to consistently use AR (Huang and Liao 2015). Yim and Park (2019) demonstrate that the possibility of using AR try-on apps in private space is

highly valued by participants with an unfavorable body image. This study also suggests that participants with an unfavorable body image are less susceptible to lower interactivity and irritation in forming their intention to adopt AR and record greater media usefulness and enjoyment.

As a natural continuum for AR acceptance and adoption, this stream focuses on examining whether the use of AR and resulting utilitarian and hedonic experiences (or motives) increase consumers' positive responses, such as satisfaction, purchase intentions, and patronage intentions (Dacko 2017; Poncin and Ben Mimoun 2014; Poushneh and Vasquez-Parraga 2017). AR enhances the holistic in-store experience, consumers' positive emotions, and perceived value and leads to improved satisfaction and patronage intention (Poncin and Ben Mimoun 2014). AR increases curiosity about the product, which enhances exploratory behavior and drives patronage intentions and willingness to buy in an omnichannel context (Beck and Crié 2018). Watson et al. (2018) suggest that augmentation triggers affective responses, which then improve purchase intentions. Hedonic motivation moderates this effect.

Decision-making

AR affects decision-making via immersive experiences and shared decision-making. Immersive experiences are facilitated by technology that offers more or better-quality sensory information and dissolves the boundary between the real and virtual worlds (Suh and Prophet 2018). As an immersive technology, AR provides believable product examination and enriches the decision-making process with additional visual and sensory information about products (Yim, Chu and Sauer 2017). We find that AR enhances three distinct immersive experiences, namely, flow, local presence, and imagery.

Flow is a psychological state in which consumers feel focused immersion, enjoyment, control, curiosity, and temporal dissociation (Javornik 2016b; Huang and Liao 2017).

Augmentation enhances flow and app-centric responses, such as app attitudes and recommendation intentions, but decreases cognitive responses (Javornik 2016b). Higher levels of flow increase the cognitive load of the immersive experience and make it difficult for consumers to process brand-related information (Javornik 2016b). Virtual liminoid theory suggests that the use of AR multisensory experience motivates consumers to decorate themselves (Huang and Liao 2017). Drawing on virtual liminoid theory, AR immerses users into flow and results in satisfaction and willingness to spend more time on AR (Huang and Liao 2017).

Presence has shifted from a sense of being present in a remote (virtual) location (see Huang and Hsu Liu 2014; Huang and Liao 2015) to sensing a virtual object close to consumers' real environment (see Hilken et al. 2017; Vonkeman, Verhagen and van Dolen 2017). For simplicity, we will call the AR type of object presence local presence. Local presence provides an authentic situated experience in which consumers believe they are actually trying on the offering (Hilken et al. 2017) in their real environment (Vonkeman, Verhagen and van Dolen 2017). AR visualization triggers local presence, increases experiential value, improves decision comfort and leads to purchase intentions (Hilken et al. 2017). Vonkeman et al. (2017) show that by increasing product affect, local presence enhances impulse buying. By providing the feeling of being close to an offering, local presence responds to the main pitfalls of online shopping with regard to the mediated nature of the experience and, in turn, influences consumers' appreciation for the product because product information feels more direct and less risky (Verhagen et al. 2014; Vonkeman, Verhagen and van Dolen 2017) and is linked with increased purchase intentions and recommendation intentions (Hilken et al. 2017; Verhagen et al. 2014).

AR permits imagining using "a visual, lasting 3-dimensional (3D) product representation against the backdrop of the natural world" (Heller et al. 2019a, 98), and the

imagery persists after AR usage (Javornik 2016b, 996). Mental imagery is central to consumer decision-making, and preconsumption evaluation would not be possible without imagination (Heller et al. 2019a). Without touching and experiencing the product directly, generating mental images of the usability of a product is challenging (Heller et al. 2019a). Heller and colleagues (2019a) show that AR offloads two distinct stages of mental imagery (i.e., imagery generation and transformation), enhances imagery processing fluency, and leads to choice. Park and Yoo (2020) show that interactivity enhances mental imagery elaboration and quality and results in positive attitudes and intentions toward products and apps. In addition, sensory modalities such as touch enhance mental imagery (Heller et al. 2019b). The effect of improved cognitive processing on decision comfort is stronger for contextual products (Heller et al. 2019a). Regarding consumers' characteristics, visualizers benefit less from local presence in terms of utilitarian value perceptions (Hilken et al. 2017), and spatial visualizers benefit less than object visualizers in terms of processing fluency, decision comfort, and WOM intentions (Heller et al. 2019a).

The extant literature discusses the influence of social conversation on retail shopping (X. Zhang, Li and Burke 2018). However, there is scarce research addressing AR optimal configuration for shared decision-making and its impact on consumer behavior (Hilken et al. 2019). Drawing on situated cognition theory (Semin and Smith 2013), researchers show that AR reduces cognitive load and enhances fluency and comfort, resulting in enhanced patronage and purchase intentions (Hilken et al. 2019; Hilken et al. 2017; Fan et al. 2020). Hilken et al. (2019) find that the optimal configuration of social AR creates a sense of social empowerment for the recommender and enhances the recommendation comfort. Their findings show that the decision comfort retrieved from social empowerment decreases if the recommender is worried that he or she might make a negative impression on the decision maker. Furthermore, they find evidence that AR creates personal choice engagement for recommenders. They also find that,

for decision makers, social empowerment enhances choice, and makes them more likely to follow the recommender's opinion. This effect decreases if the recommender exhibits a strong persuasion goal.

Virtual self

AR enables consumers to access their sense of self because consumers can explore different personality possibilities and are motivated to decorate their virtual self (Huang and Liao 2017) and to develop their ideal self (Huang 2018). Self-referencing is a mental simulation of imagining oneself using a product (Huang 2019), in which consumers process information by relating it to their self-structure or aspects of it (Burnkrant and Unnava 1995). Concretely, when using AR makeover apps, consumers see their real body and virtual product information over it, which triggers self-focused thoughts and connects consumers' self with brands (Baek, Yoo and Yoon 2018; Smink et al. 2019; Huang 2019; Phua and Kim 2018). Self-referencing is one of the main mechanisms for shaping the relationship between consumers and brands (Huang 2019).

The self-focused perspective on humanizing brands is composed of two related dimensions: "consumers may perceive a brand as being 'like me' (having brand-self congruity) or as being 'close to me' as a person (having brand-self connections)" (MacInnis and Folkes 2017, 363). With AR, self-brand congruity enhances brand attitudes and purchase intentions (Phua and Kim 2018). MacInnis and Folkes (2017) propose that, as self-brand congruity increases, the brand becomes part of the self (drawing on the extended self; Belk, 1988); thus, self-brand connection refers to the extent to which individuals use brands to reinforce and express their self-identity. Baek, Yoo, and Yoon (2018) demonstrate that AR-based self-referencing enhances self-brand connection and purchase intentions. Furthermore, their

research suggests that more narcissistic consumers report stronger self-brand connections because narcissists who view themselves in AR are more likely to rely on self-referent cues.

Negative effects

The main perils of AR to be addressed are privacy concerns and media irritation. According to Poushneh (2018), AR enhances consumer satisfaction (vs. product pictures on websites) because consumers positively judge the trade-off between the level of augmentation quality and the value they attribute to the control of their personal information (Poushneh 2018). The study follows equity theory to explain that, on the one hand, compared to non-AR product presentation with a picture of the consumer's own face or a model, the AR virtual dressing room is more informative and fun. On the other hand, compared with different AR apps, a self-viewing app that augments the faces of consumers raises the highest privacy concerns. Thus, Poushneh (2018) confirms a burden of AR when it needs to film the user's own body or direct environment. The positive effect of decision comfort is attenuated by customers' privacy concerns (Hilken et al. 2017). In stores, consumers' discomfort caused by a lack of privacy in AR negatively impacts brand attitudes (van Esch et al. 2019). According to Poushneh (2018), AR and non-AR pictures of consumers' own faces are perceived as more intrusive than model pictures. Although both own-face conditions (AR and picture) are deemed more intrusive, this does not lead to reactance; surprisingly, it leads to greater willingness to disclose personal information (Smink et al. 2019). Therefore, the positive effects of AR seem to outweigh the potential negative effects.

Compared to traditional ecommerce websites, AR is considered more novel and interactive but creates more media irritation (Yim and Park 2019). To be used in the long term, the technology speed and maturity level of AR need improvements (Rese et al. 2017), and AR content needs to be more realistic and accurately represent sizes (Yim and Park 2019). AR is

significantly better at creating immersion, for consumers with low media experience (Yim, Chu and Sauer 2017), and perceptual-specific curiosity is dependent on the perception of a novel and complex system (Beck and Crié 2018).

Future research agenda

Below, we propose avenues for future research to clarify the effects of AR into four research streams, including a new focus on customer-to-customer communication in a social AR setting.

The first stream differentiates between utilitarian and hedonic experiences or motivations for adopting and using AR technology. This stream contributes to knowledge of AR in retail by showing that the pursuit of both utilitarian and hedonic experiences and value drives the acceptance and adoption of AR technology (Rese, Schreiber and Baier 2014; Pantano, Rese and Baier 2017). Furthermore, the findings within this research stream provide empirical evidence that the use of AR technology and the consequent utilitarian and hedonic experiences are related to positive outcomes, such as brand attitudes and purchase intentions (McLean and Wilson 2019; Plotkina and Saurel 2019). Within this research stream, the natural continuum is to examine the boundary conditions under which AR adoption and its positive consequences are more likely to occur. Some recent studies provide initial insights into this issue by examining consumer characteristics, such as cognitive innovativeness (Huang and Liao 2015) or body image (Yim and Park 2019). Of course, more research on the moderating effects of consumer characteristics, such as personality and demographics, is needed. Additionally, other contextual moderators should be examined. Thus far, AR sensory marketing is mostly visual, although other senses (e.g., sound, touch, smell) may influence the acquisition of cognitive information about online and offline offerings and influence consumer behavior (Marketing Science Institute 2018). AR applications are typically brand-based content; thus, the search is limited within brands, which can reduce the number of products

with similar attributes. Future research should determine whether AR applications should be delivered by retailers (e.g., Amazon, Marks and Spencer) or by manufacturers (e.g., L'Oréal, Unilever) and what product presentation would be an optimal choice set (e.g., comparable vs. non-comparable products, small vs. large choice set). Therefore, we propose that one key research question for future research on AR in retail is the following:

RQ1: What are the boundary conditions under which AR technology a) is adopted by consumers and b) leads to positive brand outcomes?

Another question that arises from the knowledge provided by the first research stream is how AR technology enables these positive outcomes. Research streams two (i.e., decision-making) and three (i.e., virtual self) in our review already pave the way to answering these questions. The research stream that examines decision-making appears to take a more transactional approach with a focus on purchase decisions, whereas the research stream that focuses on the "virtual self" examines mechanisms by which the use of AR technology shapes consumers' brand relationships. Both streams suggest that AR technology use enhances processes of imagination (i.e., imagery, Park and Yoo 2020; local presence, Verhagen et al. 2014; self-referencing, Huang 2019). Past studies confirm that enhanced imagination influences both decision-making at the transaction level (e.g., Hilken et al. 2017; Heller et al., 2019a) and the formation of brand relationships in the long term (e.g., Huang 2019). However, research on the decision-making stream also recognizes that AR may immerse users in a psychological state of flow (Huang and Liao 2017), which may hinder the processing of brand-related information (Javornik 2016b). Clearly, more research is needed to understand the interplay of enhanced imagination and flow in shaping consumers' decisions and brand relationships.

RQ2: How, when, and why does AR technology use lead to a) enhanced imagination and b) flow?

RQ3: How, when and why are imagination processes and the state of flow related to both a) transactional decision-making and b) consumer-brand relationships?

Because AR enhances self-referencing, the tendency to humanize brands may be stronger. Previous research in AR has examined the self-focused perspective on humanizing brands. The same drivers of humanizing brands (sociality, effectance, and the elicitation of agent knowledge) in the self-focused perspective can enhance the relationship-focused perspective; furthermore, the self-focused perspective influences the relationship-focused perspective (MacInnis and Folkes 2017). AR influences the view that brands are like humans (anthropomophism; van Esch et al. 2019) or are like oneself (self-brand connection; Baek, Yoo and Yoon 2018) and that brands are in a relationship with oneself (brand love, Huang 2019). Another relationship of interest is brand attachment. Following MacInnis and Folkes (2017), as consumers experience a strong self-brand connection, they are likely to become attached to a brand as a relationship partner. Studying the extent to which AR creates brand attachment entails complementing current knowledge on self-brand connection with prominence (C. W. Park et al. 2010). Prominence refers to the salience in consumers' memory of the cognitive and emotional bond between consumers and brands (MacInnis and Folkes 2017). Strong brand attachment may motivate consumers to invest (time, money, reputation) in the brand. Brand attachment is linked to transactional outcomes, such as brand loyalty behaviors, and to relationship outcomes, such as brand advocacy (C. W. Park et al. 2010).

RQ4: How, when, and why do the processes of humanizing brands lead to a) transactional outcomes and b) consumer-brand relationships?

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An interesting emerging theme in both decision-making and virtual self-research streams is the social use of AR. Shoppers often wish to conduct their shopping with others and may use AR to share their perspective and enrich the decision-making process. For example, shopping with others occurs when decision makers ask for opinions on the best paint color from a recommender through AR layers (Hilken et al. 2019), and when groups interact with a product to make the best car design (Carrozzi et al. 2019). Research on shared decision-making shows that consumers can obtain recommendations and feedback from their peers by sharing their AR images. Decision makers feel more empowered when they receive image-enhanced recommendations (Hilken et al. 2019). Furthermore, researchers find that shared decision-making in AR creates social empowerment and results in positive transactional outcomes, namely, choice for the decision maker and enhanced desire for the product for recommenders.

We believe that the social use of AR is also relevant as a channel for expressing the self. Belk's (2013) extended self in a digital world comprises sharing and co-construction of the self. Sharing AR holograms may contribute to consumers' personality exploration, whether in a private mode (only with friends and family) to enhance decision-making, or in a public mode (accessible to anonymous viewers) to enhance the self and other-oriented perceived value (ethics and connectedness, Salo et al. 2013). When an AR hologram is shared, consumers using AR simultaneously maintain social differentiation and assimilate with peers (Carrozzi et al. 2019). The results demonstrate that the connectivity of AR customization enables users to compromise on some design aspects (color, location) while also expressing their personal preferences. In addition, whether consumers use personal or shared devices influences whether consumers look for differentiation or assimilation. At the same time, consumers with AR can receive advice from "purchase pals" online or offline. "The girls in the dressing room act as extended self 'purchase pals' in the traditional sense of the term" (Belk 2013, 487). "Purchase pals" serve a similar role of reassurance when using AR. Social AR entails opportunities for

future research on the co-construction of the self with other entities such as brands and possessions. Disinhibition online makes it easier for friends and anonymous viewers to provide feedback for the co-construction of the self. Building an aggregate extended self may take a new form as holograms can be a collaborative project among friends, families or anonymous viewers. Thus, the boundaries between the self and other entities are less clear; for example, consumers report a dissolution of self-brand boundaries (Scholz and Duffy 2018). Further research should examine consumer-consumer interaction and how the aggregate self, of two "purchase pals" or a larger social group, may incorporate the brand into consumers' self-representations.

RQ5: How, when and why do consumers share their AR images, and how does this change consumer behavior?

Most studies in the first three research streams focus on examining the positive effects of AR technology. The fourth research stream, the negative effects, raises issues such as privacy concerns in AR usage. It is crucial to investigate how the social acceptance of AR will constrain the use of AR holograms if consumers think their information is continuously being collected. Privacy concerns with AR are particularly obvious because the camera needs to be pointed at the content it augments, such as consumers' bodies or homes, and may retrieve more contextual information (notably, face recognition) than desired and used for information filtering. In the context of diminished trust among e-commerce consumers (Reibstein, Day and Wind 2009), it is crucial to study how AR can improve online trust-building and diminish privacy concerns. Research is especially needed to clarify findings concerning the novelty effect of AR, because some studies have found an impact (Scholz and Duffy 2018) while others have rejected its confounding effect (Heller et al. 2019a; Carrozzi et al. 2019).

It seems that most studies that examine negative effects related to AR actually examine factors that might hinder the usage of AR. The use of AR technology, especially its social use, may raise new problematic issues. For example, Vonkeman, Verhagen and van Dolen (2017) find that AR technology enhances impulse buying, which might lead to negative emotions such as guilt and shame (Yi and Baumgartner 2011). Sharing holograms in the virtual world may create a sense of shared digital possessions or a shared sense of space and may be similar to online brand communities (Carrozzi et al. 2019). Jussila et al. (2015) note that such a sense of possession (i.e., psychological ownership) may lead to property rights violations. Potentially, social AR might give rise to bullying behaviors, which are harmful for both consumers and brands (Breitsohl, Roschk and Feyertag 2018). We encourage more research on potentially problematic outcomes of AR technology usage.

RQ6: When, how, and why does AR technology use lead to negative consequences?

Conclusions

The focus of this study was to answer the following questions. 1) What is the current state of research in the field of AR in retail? 2) What are the key consumer behavior phenomena related to AR in retailing? 3) What are the consequences of AR usage on consumer attitudes and behavior? 4) Which research gaps remain to be addressed? To do so, we conducted a systematic literature review and organized the results in a conceptual framework. Four themes emerge from our analysis that show the potential of AR to create hedonic and utilitarian value, improve decision-making, and to enhance personalization of the virtual self.

Then, this study warns about negative effects of AR usage. Research is needed in each theme, notably, the increasingly social aspect of AR should be researched further.

Our systematic review, like any review, has several limitations (Boell and Cecez-Kecmanovic 2015). First, the literature examined was chosen purely through the inclusion and exclusion criteria. The implication of this choice is that we might have missed some of the uses of AR because of this selection. Second, the literature streams are fragmented and interdisciplinary, and we focus on consumer research. The last difficulty is the lack of clarity in naming the technology used; a virtual try-on can be fully virtual, based on virtual reality, or based on AR.

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Appendices

Appendix A
In Appendix A, the first three themes are presented in independent Tables, while negative effects are presented throughout the Tables.

Table A.1 Utilitarian and hedonic value

Study	Methods	Sample	Theory base	AR variable(s)	Process variables	Boundary condition(s)	Outcome variable(s)	Key findings
(Poncin and Ben Mimoun 2014)	Field study	140 consumers in toy store	-	-	Perceived store atmospheric, Utilitarian and hedonic value, Emotion	-	Satisfaction, Patronage intention	Enhanced holistic in-store experience, perceived value and positive emotion are shown to improve satisfaction and patronage intention.
(Rese, Schreiber and Baier 2014)	Mixed methods	275, mostly students	Technology acceptance model	-	Perceived informativeness, Perceived enjoyment, Perceived ease of use, Perceived usefulness	-	AR attitude, Intention to use AR	TAM predicts customer acceptance of augmented reality at the point of sale. Online reviews can replace online questionnaires in experimental settings to study the TAM model. However, text samples are not suitable.
(Dacko 2017)	Survey	779 young consumers	-	-	Aesthetics, Playfulness, Consumer ROI, Service excellence	-	"Unique" perceived value, Preference, Patronage intention	AR is expected to provide more efficient and entertaining shopping experiences, more complete information, and more decision certainty, resulting in positive behavioral intentions. Privacy concerns are considered a drawback of AR use.
(Pantano, Rese and Baier 2017)	Experiment	318 students	Technology acceptance model	Aesthetics quality, Interactivity, Response time, Quality of information	Perceived ease of use, Enjoyment, Perceived usefulness	-	Attitude toward using, Behavioral intention	AR enhances consumer intention to shop online. Few differences between German and Italian samples related to consumers' motivations to use AR.

(Poushneh and Vasquez-Parraga 2017)	Experiment	99 mostly young consumers	Equity theory	Interactivity	User experience	Trade-off between price and value, Users' information privacy control	User willingness to buy, User satisfaction	AR significantly contributes to a positive user experience and in turn influences user satisfaction and willingness to buy.
(Rese et al. 2017)	Experiment	978 students	Technology acceptance model	-	Perceived informativeness, Perceived enjoyment, Perceived ease of use, Perceived usefulness	-	App attitude, Intention to use AR	Both markerless AR apps outperform marker-based AR apps in the TAM model constructs, providing enhanced recommendation and usage intentions. Both virtual mirrors are described by their utilitarian aspects.
(Beck and Crié 2018)	Experiment	469 students	-	-	Perceptual specific curiosity	-	Patronage intention, Purchase intention online and offline	AR-based fitting room influences perceptual specific curiosity, patronage intention and purchase intention online and offline.
(Poushneh 2018)	Experiment	80 young and 329 consumers	Equity theory	Augmentation quality	Users' control of access to personal information	-	User satisfaction	Both augmentation quality and users' control of access to personal information enhance user satisfaction.
(Watson et al. 2018)	Experiment	162 mostly young consumers	Stimulus-organism-response model	Augmentation	Positive affective response	Hedonic motivation	Purchase intentions	Augmentation creates a more positive emotional response (vs. no augmentation) and enhances purchase intentions. Consumers who are more concerned with hedonic fulfillment derive greater pleasure from the augmented experience.
(Huang et al. 2019)	Survey	207 students	Self-determination theory, Self-evaluation theory	Modality, Synchronous sense of ownership control, Re-processability	-	Body surveillance, Fashion consciousness	Rapport experience	AR try-on features positively affect consumers' rapport experience. Both body surveillance and fashion consciousness moderate the effects of AR try-on service system characteristics on consumer rapport experience.

(McLean and Wilson 2019)	Survey	441 consumers	Technology acceptance model	Interactivity Vividness Novelty	Perceived ease of use, Enjoyment, Perceived usefulness, Subjective norms	Utilitarian and hedonic motivation	Brand engagement, Satisfaction with app experience, Brand usage intention	AR attributes and technology acceptance attributes have a positive impact on brand engagement, increased satisfaction with app experience and brand usage intentions. These relations are sometimes moderated by utilitarian and hedonic motivation.
(Plotkina and Saurel 2019)	Experiment and qualitative study	415 consumers and 49 consumers	Technology acceptance model	-	Convenience, Ease of use, Usefulness, Enjoyment	-	Attitude toward app, Purchase intention	Deals with the extent to which apparel M-commerce should display visuals close to consumers' body fit and ethnicity. Enjoyment (vs. utilitarian technology features) better explains attitude toward the AR.
(Rauschnabel, Felix and Hinsch 2019)	Survey	201 students	Information integration theory	Augmentation quality	Utilitarian benefits, Hedonic benefits, Inspiration	-	Attitude toward AR, Brand attitude	Both utilitarian and hedonic benefits contribute to attitudes toward the app.
(Yim and Park 2019)	Survey	406 students	-	Interactivity, Media irritation	Media usefulness, Media enjoyment	Body image	Attitude toward AR, Intention to adopt AR	Participants with a favorable body image recorded greater media usefulness and enjoyment, more favorable attitudes, and greater adoption intentions toward AR. Individuals with an unfavorable body image are less susceptible to interactivity and irritation in forming their intention to adopt AR.
(T. Zhang et al. 2019)	Survey	208 consumers	-	-	Usefulness, Ease of use, Enjoyment, Socialization, Product risk, Privacy risk	-	Attitude towards app, Purchase intention	Perceived usefulness, perceived enjoyment and perceived privacy risk enhance attitudes toward the app, which positively impacts purchase intentions.
(Bonnin 2020)	Experiment	289 young consumers	-	-	Utilitarian and hedonic value, Perceived product risk, Store attractiveness	Familiarity with AR	Patronage intention	Shows that AR decreases the perceived risk of buying a product online and increases patronage intention. The more familiar consumers are with AR, the more perceived product risk decreases and patronage intention increases.
(Hinsch, Felix and Rauschnabel 2020)	Survey	145 young consumers	-	Hedonic benefits, Augmentation quality	Inspiration, Nostalgia	-	Behavioral inspiration	AR enhances inspiration as a process from inspired-by into inspired-to through nostalgia. The wow effect is not a significant mediator of inspiration.

| (Yang, Carlson and Chen 2020) | Experiment | 432 consumers and 156 students | | - | - | Curiosity, Attention | Novelty | Attitude toward ad | AR increases curiosity and attention and results in positive attitudes toward the ad. However, AR effectiveness in advertising suffers from a novelty effect. |

Table A.2 Decision-making

Study	Methods	Sample	Theory base	AR variable(s)	Process variables	Boundary condition(s)	Outcome variable(s)	Key findings
(Huang and Hsu Liu 2014)	Survey	344 students	Narrative theory	-	Presence, Perception narrative, Media richness	-	Aesthetics, Playfulness, Consumer ROI, Service excellence	Although presence has a significant effect on aesthetics and service excellence, narrative experience provides the highest experiential value.
(Verhagen et al. 2014)	Experiment	366 students	-	-	Local presence, Product tangibility, Product likability	-	Online purchase intentions	AR is more efficient at delivering local presence than other product visualization formats. Local presence improves online purchase intentions through product tangibility and product likability.
(Huang and Liao 2015)	Survey	220 students	Technology acceptance model, Experiential value	-	Presence, Perceived ease of use, Perceived usefulness, Aesthetics, Service excellence, Playfulness	Cognitive innovativeness	Sustainable relationship behavior toward AR	Usefulness, ease of use, service excellence, aesthetics, and playfulness are the five key factors that foster consumers' sustainable relationship behavior toward using AR. Consumers with high cognitive innovativeness are more likely to use AR.
(Javornik 2016b)	Experiment	60 students	Flow theory, Theory of interactive media effects	Augmentation	Flow	-	App attitude, Revisit intentions, Recommendation intentions, Cognitive responses	Perceived augmentation enhances flow as well as affective and behavioral intentions toward the app. The results of cognitive responses indicate negative correlations, where more immersed consumers reported fewer thoughts.
(Verhagen, Vonkeman and van Dolen 2016)	Experiment	366 students	-	-	Mental tangibility, Physical tangibility, Specificity, Perceived diagnosticity	-	Online purchase intentions	Perceived diagnosticity positively mediates the path from mental and physical tangibility to purchase intentions.

(Hilken et al. 2017)	Experiment	832 students	Situated cognition theory	Environmental embedding, Simulated physical control	Spatial presence, Utilitarian and hedonic value, Decision comfort	Style of information processing, Awareness of privacy practices	Patronage intentions, Purchase intentions	AR simulates physical control and environmental embedding and enhances consumers' value perception and spatial presence, decision comfort and behavioral intentions. The effect of spatial presence on utilitarian value perceptions is greater for customers with a semantic information processing style.
(Huang and Liao 2017)	Survey	336 students	Flow theory, Virtual liminoid theory	Self-location, Haptic imagery	Sense of body ownership, Ownership control, Self-explorative engagement, Flow	-	Spend more time on AR, Satisfaction	AR can motivate consumers to decorate their virtual self. When using AR, the rich multisensory experience immerses users into flow through the decorating psychological states.
(Vonkeman, Verhagen and van Dolen 2017)	Experiment	212 students	Construal level theory	Interactivity, Vividness	Local presence Product risk Product affect	-	Urge to buy impulsively	Interactivity and vividness of AR-based product presentation improves local presence and enhances impulse buying.
(Yim, Chu and Sauer 2017)	Experiment	258 and 801 students	-	Interactivity, Vividness	Immersion, Media usefulness, Enjoyment	Previous media experience, Media novelty	Attitude toward the medium, Purchase intention	AR-based product presentations are superior to traditional web-based product presentations in the effect on media novelty, immersion, enjoyment, usefulness, enhanced attitude toward medium, and purchase intention.
(Zhao et al. 2017)	Mixed method	36 young consumers	-	-	Shopping method, Product value, Sensory channel	-	Mental workload	Males' mental workloads are significantly higher than females' loads. For males, the mental workload of high-value products is significantly higher than that of low-value products.
(Brito, Stoyanova and Coelho 2018)	Experiment	150 consumers	Theory of transfer	-	Brand awareness, Category familiarity, Product website interaction, Emotional intensity, Innovativeness, Perceived risk	Opinion Leadership	Emotional response, Brand attitude, Interactive response, Future relationship with the brand	Participants show higher emotional response, interactive response and brand evaluation in marker-based AR and markerless AR than in conventional interactive technology.

Citation	Method	Sample	Theory	AR Features	Mediators	Moderators	DV	Findings
(Huang 2018)	Survey	232 students	-	Audiovisual, Haptic, Rehearsability, Symbol sets, Reprocessability	Hedonic value, Functional value, Social value, Epistemic value	-	Price premium	All paths are significant and positive except epistemic value on the price premium.
(Carrozzi et al. 2019)	Experiment	210 students	Socially situated cognition theory	Customization	Social assimilation and differentiation	-	Psychological ownership	Customization of AR holograms generates psychological ownership toward the digital product through social assimilation and differentiation depending on the device.
(Heller et al. 2019a)	Experiment	914 consumers	Mental imagery theory	Generation, Transformation	Processing fluency, Decision comfort	Consumer processing type, Product contextuality	Choice, WOM	The interaction of imagery generation and imagery transformation enhances processing fluency, decision comfort and WOM intentions.
(Heller et al. 2019b)	Experiment	489 students	Active inference theory	Sensory control modalities	Mental intangibility, Decision comfort	Multi-sensory feedback assessment	Willingness to pay	AR-based touch reduces mental intangibility and increases decision comfort, thereby enhancing consumers' willingness to pay. The reduction of mental intangibility is particularly strong for consumers high in assessment orientation.
(Hilken et al. 2019)	Experiment	458 students, 295 consumers	Socially situated cognition theory	POV sharing format, Communicate acts format	Recommendation comfort, Social empowerment	Recommenders' impression management concerns, Recommenders' persuasion goal	Choice, Desire for product, Usage intentions, WOM	Social AR enables decision-makers to share their point of view and to receive recommendation in formats that make it more likely to impact choice. In addition, social AR increases social empowerment and enhances the recommender's comfort, desire for the product and positive intentions.
(Song, Baek and Choo 2019)	Survey	99 students	Socially situated cognition theory	Environmental embedding, Simulated physical control	Immersion, Psychological ownership	Prior experience	Decision comfort	AR characteristics enhance immersion and ownership and result in decision comfort. Prior experience with AR decreases immersion.
(Fan et al. 2020)	Experiment	493 students	Situated cognition theory	Environmental embedding, Simulated physical control	Cognitive load, Cognitive fluency	Product type	Attitude toward product	AR-based environmental embedding and simulated physical control reduce cognitive load, enhance cognitive fluency and lead to improved product attitudes. Product type moderates the impact of AR on cognitive fluency but not on cognitive load.

(Park and Yoo 2020)	Survey	302 consumers	Mental imagery theory	Interactivity	Mental imagery	Involvement	Attitude toward product, Behavioral intentions toward product and app	Controllability and playfulness of AR influence mental imagery elaboration and quality, which enhance attitude toward a product and behavioral intentions toward the product and the app. The level of involvement moderates the effect of interactivity on mental imagery.

Table A.3 Virtual self

Study	Methods	Sample	Theory base	AR variable(s)	Process variables	Boundary condition(s)	Outcome variable(s)	Key findings
(Baek, Yoo and Yoon 2018)	Experiment	174 students	Self-attention theory	-	Self-viewing, Self-brand connection	Narcissism	Purchase intention	Self-viewing enhances both self-brand connection (SBC) and purchase intention. Narcissistic individuals show heightened SBCs and purchase intentions when they view themselves (vs. others) in the AR virtual mirror.
(Brengman, Willems and van Kerrebroeck 2018)	Experiment	277 students	-	-	Perceived ownership	-	Product attitudes, Purchase intentions	The results demonstrate that (vs. laptop vs. mobile phone) mobile augmented reality increases feelings of perceived ownership, which positively affects product attitudes and purchase intentions.
(Phua and Kim 2018)	Survey	311 consumers	-	-	Self-referencing, Self-brand congruity, Perceived humor	-	Brand attitude, Purchase intention	AR induces self-brand congruity, self-referencing and perceived humor, enhancing brand attitude and purchase intention. Self-brand congruity better explains purchase intention. Perceived humor is more important than self-referencing for brand attitude.
(Scholz and Duffy 2018)	Ethnographic study	31 young women	-	-	Branded app as personal space, Dissolving of boundaries and foregrounding the consumer, Protecting and dissolving the consumer/brand fusion	-	Consumer brand relationship	AR can result in more intimate consumer-brand relationships if marketers are able to keep the brand and transactional aspects of the app in the background. Quality problems of AR content are forgiven if consumers are foregrounded in the consumer-brand relationship.
(Huang 2019)	Experiment	232 consumers	-	-	Sense of ownership control, Rehearsability, Self-referencing, IT identity	-	Brand love	AR is higher in interactive effect and higher in audiovisual effect. Brand love is positively influenced by self-referencing and by IT identity.
(Smink et al. 2019)	Experiment	319 consumers	Equity theory, Reactance theory	-	Self-referencing, Perceived informativeness, Perceived enjoyment, Perceived intrusiveness	-	Brand attitude, Purchase intention, Willingness to share personal data	AR mainly has positive effects on brand responses and willingness to share data.

(van Esch et al. 2019)	Field-study	319 consumers	-	-	Anthropomorphism, Confidence, Convenience of the transaction, Discomfort, AR innovativeness, Barriers to use, Side effects of the technology	-	Brand attitude	Anthropomorphism positively mediates most process variables (but not discomfort) which in turn positively influence attitude toward the brand (not innovativeness of AR).
(Xu et al. 2019)	Experiment	150 young consumers	-	-	Self-referencing	Quality beliefs, Taste beliefs, Luxury brand	Attitude toward product	Self-referencing mediates the effect of AR technology on consumers' product attitude, and the effect is attenuated when consumers hold quality beliefs rather than taste beliefs or when the product is a luxury brand.

Appendix B.

Table B.1. Main theoretical definitions

Theoretical foundation	Description in context	Reference
Active inference theory	This theory suggests that to express a judgment or make a choice for a product or service, consumers rely on sensory control and feedback inferred from their behavior when interacting with an object.	(Heller et al. 2019b)
Construal level theory	This theory suggests that psychological proximity induces low-level construal of the object. When low-level construals are triggered, it makes the "here and now" more salient, which leads to decreased self-control and an increase in impulsive behavior.	(Vonkeman, Verhagen and van Dolen 2017)
Equity theory	This theory suggests that, when AR users make a decision, they balance the benefits against the costs to ensure that they receive more than what they sacrifice.	(Poushneh 2018)
Flow theory	Flow is defined as an optimal tradeoff between challenges faced in an environment and a person's skills, so the person feels immersed in a challenging activity.	(Javornik 2016b)
Information integration theory	The theory suggests that existing associations can be altered once new related information is processed and integrated into existing knowledge. In the context of brands, brand attitudes are influenced when consumers receive, process, and integrate new information (e.g., from an app) related to their existing brand associations.	(Rauschnabel et al. 2019)
Mental imagery theory	Most researchers agree on visual imagery as an important factor of mental imagery. Customers imagine a visual representation of the use of offerings to predict outcome of use and notably reduce uncertainty about the relation of product attributes to satisfaction. Mental imagery through AR simulates direct experience in an online environment.	(Heller et al. 2019a)
Reactance theory	This theory suggests that consumers who perceive their control or freedom to be threatened try to resist persuasion and respond negatively. This negative effect can spill over to brand attitude and purchase intention.	(Smink et al. 2019)
Self-attention theory	This theory suggests that when AR users encounter information, self-focused attention facilitates the accuracy of elaboration of self-referent information.	(Baek, Yoo and Yoon 2018)
Socially situated cognition theory	This theory suggests that people rely on each other's support to complete a task. A situated cognition perspective implies that information processing occurs within (i.e., is embedded in) and actively exploits (i.e., embodies) a person's environment rather than occurring as an abstract activity in the mind.	(Hilken et al. 2019)
Stimulus-organism-response model	This model suggests that, when individuals encounter a stimulus, it triggers an internal state called an organism, which in turn delivers responses.	(Watson et al. 2018)
Technology acceptance model	In the basic TAM model, two specific beliefs with regard to technological innovation—perceived ease of use (PEOU) and perceived usefulness (PU)—are linked to attitudes and behavioral intentions toward using the innovation. The intention to use an innovation or an available system is used as a proxy for user acceptance.	(Pantano, Rese and Baier 2017; Rese, Schreiber and Baier 2014; Rese et al. 2017)

Theory of interactive media effect	This theory suggests that the medium of communication can trigger affordances. Affordances are action possibilities that can trigger action on the part of the user and/or serve as symbolic representational cues on the interface and can affect users' psychology.	(Javornik 2016b)
Virtual liminoid theory	This theory suggests that when AR users go from a physical self to a virtual self (also called liminality), they trigger a decorating psychological state that motivates decoration of the stature of their virtual self.	(Huang and Liao 2017)